The Locust Borer

E. H. Wollerman [1]

The locust borer, *Megacyllene robiniae* (Forst.), is a native insect. Its original range probably coincided with that of its host tree the black locust (*Robinia pseudoacacia* L.): along the Allegheny Mountains from Pennsylvania to Georgia and in the Ozark Mountain Region.

The widespread use of black locust as a shade tree and, more recently, its extensive use in reforestation and land-reclamation plantings have enabled the borer to disperse generally with its host over most of the United States. It may now be found from eastern Canada south to the Gulf States and Westward to Washington, Colorado and Arizona.

Many of the trees used in reforestation and land reclamation have been planted in soils badly eroded by wind or water and severely depleted of soil nutrients by poor farming practices. Such plantings provide an ideal environment for the locust borer and pave the way for subsequent serious damage.

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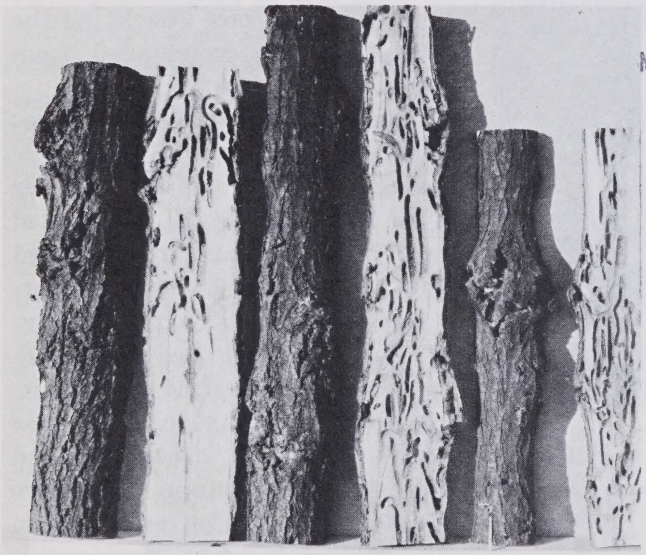

Figure 1.—Internal damage to black locust and external appearance.

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Injury

Borer larvae tunnel into and through the trunk and limbs of an infested tree (fig. 1), physically weakening it and making it susceptible to wind breakage. Repeated attacks often result in the production of nothing more than sprout growth (fig. 2).

The most obvious signs of severe borer attack in a stand of black locust are the numerous dead and broken limbs. Closer inspection reveals knotty swellings on the trunks (fig. 3). Indications of live borers within the tree vary with the season. Wet spots on the bark in early spring when the buds swell mark the activity of young larvae in the inner bark. In late spring or early summer, the developing larvae work into the sapwood and push white wood dust from their tunnels. When the larvae burrow more deeply and reach the heartwood in late summer, the wood dust becomes yellow. Wood dust may accumulate in a ring around the base of a heavily infested tree.

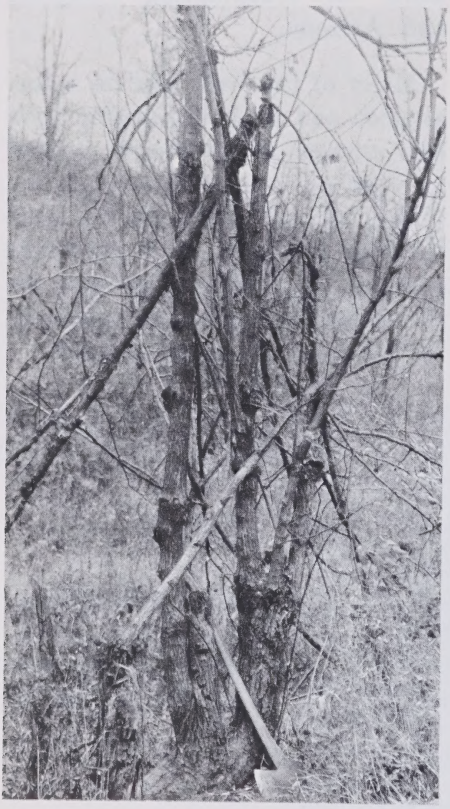

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Figure 2.—Black locust restricted to shrub form by repeated attacks of the borer.

The degree of damage varies in different locations according to the vigor of the trees and the influence of environmental factors such as light, temperature, drought, fire, grazing, and pruning. As tree vigor increases, borer damage decreases. Within locust stands older than 10 years, the thrifty dominant trees are able to overcome attack, but the slowly growing overtopped trees are badly damaged or killed.

Light and temperature influence attack by their effects on the female beetles. For example, when the air is warmer than 75° F., the shaded parts of tree trunks are preferred for egg laying; whereas, at temperatures below 70° F., trunks receiving full sunlight are preferred. Thus, when the weather is cool during the egg-laying season, fewer eggs are laid in densely shaded stands of locust than in those more exposed to light. Conversely, when the weather is warm during this period, more eggs are laid on trees growing in the shade.

Although black locust is a shal-

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Figure 3.—Black locust with bark removed in early spring. Dead tissue scars are points of attack by young larvae.

low-rooted specis, it will grow on poor sites. Trees growing on such sites are subject to serious damage during periods of prolonged drought. Drought-weakened trees are especially susceptible to borer attack.

Trees in stands that have been burned over are especially susceptible to borer damage. This is because of decreased vigor, caused either directly by damage to the thin bark of young trees or indirectly through destruction of leaf mold and litter.

Grazing of livestock can also contribute to borer damage in black locust. In addition to weakening the tree by feeding on foliage and young succulent growth and bark, cattle reduce site quality and tree vigor by compacting the soil.

Pruning creates abnormally favorable conditions for egg laying: crevices around wounds and callous tissue are ideal for oviposition.

Bark thickness is reported to be related to borer damage. Old trees with coarse thick bark are not damaged as much as thin-barked young trees. However, the branches of older trees are often infested (fig. 4).

Occasionally a black locust is found with no borer damage. It has been suggested that this may be due to a possible genetic resistance to borers. However, recent studies of such selected trees, vegetatively propagated and planted in different locations, have shown that, although the trees varied in the number of borer attacks they sustanied,

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Figure 4.—Mature black locust on an old farm lane. Borers were found only in limbs from 1½ to 4 inches in diameter.

good growing conditions were more important than genetic resistance in reducing susceptibility to borer damage.

The locust borer is not known to attack any of the nine species in addition to the black locust that occur within the genus *Robiniae*, nor does it damage honeylocust (*Gleditsia triacanthos* L.).

Description

The adult locust borer is a slender "long-horned" beetle about ¾ inch long. The jet black background color is marked with bright yellow bands, one of which is **W**-shaped, that extend across the thorax and elytra. Legs and antennae are yellow. Males and females are similar in appearance.

The mature larva is white and about 1 inch long and ¼ inch in diameter (fig. 5). The freshly formed pupa is creamy white and about ¾ inch long. Since the larval and pupal stages are spent within

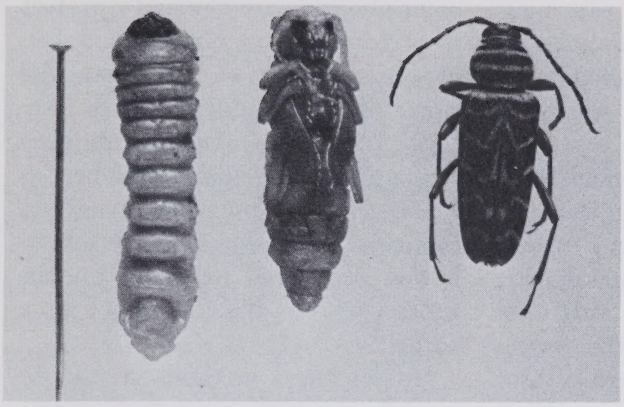

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Figure 5. — Late life stages of the locust borer: Mature larva, pupa, and adult beetle. (Pin shows relative size.)

the tree, they are not seen by the casual observer.

Seasonal History

The adult is the most conspicuous form of the locust borer. Adults first appear when goldenrod is in bloom , and are most abundant during September, when they are commonly found feeding on pollen of goldenrod blossoms during the mornings. The females prefer to lay their eggs in rough bark crevices and around wounds on the trunks of black locust (fig. 6). Egg laying is done in September and early October, mostly during the afternoons, but occasionally until late in the evening. Some adults may still be seen in late October.

The eggs are white ovals, about 1/32 inch wide and 3/32 inch long. They are laid singly but prolifically in small areas. The eggs hatch in about a week, and the small white larvae bore into the inner bark. Each larva makes a small hibernation cell and rests there over the winter. Activity is resumed in the spring at the time the leaf buds

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Figure 6.—Locust borer egg on bark. (Pin shows relative size.)

begin to swell. Oozing sap may then be seen around small holes in the trunk. The larvae soon bore into the woody part of the tree. The excavated galleries are enlarged through the spring and early summer months until they are 3 to 4 inches long and about ¼ inch in diameter. During this time the larvae grow to full size.

By mid-July most of the larvae have matured and transformed into the pupal stage, which is completed between the end of July and the first 2 weeks of August. As the larva increases in size, it enlarges its tunnel to the exterior. The mature beetle emerges through this opening.

The timing of these events in the life history of the borer varies in different parts of the country according to differences in climate.

Preventing Attack

Black locust shade trees or lawn specimens can be protected from borers by spraying the trunks and the larger limbs with a lindane emulsion. To prepare small amounts of the spray, add 2 tablespoons of a 20-percent emulsifiable concentrate to 1 gallon of water. For larger amounts add 3 pints of the concentrate to 50 gallons of water. Spray in the spring at the time the buds are opening. Repeat the application in 10 to 14 days. This treatment is directed at the active young larvae that are enlarging their excavations just below the bark and repeatedly return to the surface of the bark to increase the diameters of the borer holes.

The same lindane spray may also be applied in late sumer to protect the trees from newly hatched larvae attempting to penetrate the bark. Spraying may be done anytime from late August through September, since the female beetles continue to lay eggs throughout this time. Spraying with chemicals is not considered practical for the protection of black locust in a forest.

Silvicultural methods should be used for control of the locust borer in forested areas. These methods consist of clearcutting (to produce vigorous sprout growth), thinning, mulching, or the use of mixed tree species in plantings. The method chosen is determined by the age, amount of borer injury, or composition of the stand.

Slow-growing young stands are very susceptible to borer attack. To circumvent damage by the insect, these stands can be cut back before borers attack them. The vigorous sprouts that follow will generally be less subject to attack.

Severely injured stands can be improved by clearcutting them during the dormant period and allowing them to regenerate from sprouts. The sprouts that follow should be thinned by removing all but the most vigorous in each group. This procedure has resulted in a good second crop of trees with very light subsequent injury.

Moderately to lightly injured stands on medium to good sites benefit from thinning. In such stands, injury is mainly confined to overtopped, intermediate, or decadent trees. Removal of these trees should reduce the borer population

and thereby help to protect the more desirable trees.

Borer injury is usually less when black locust is grown in mixture with other tree species than when grown in pure stands. Mixed stands usually produce denser shade and more leaf litter than do pure stands of locust. The trees are more vigorous when nutrients from decomposed leaf litter are available. Thus, the addition of several inches of hardwood leaves in pure locust stands results in accelerated growth in height and diameter for several years after the treatment and should reduce chances of serious borer damage.

Old black locust trees with stag-headed tops serve as brood trees for the borer. Removal of these trees from the vicinity of planting areas should be helpful in reducing damage to the young planted trees. These large brood trees should be cut during the dormant period and either peeled or burned so as to destroy the borer larvae.

Pesticide Precautions

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals —and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or when they may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

WARNING: Recommendations for use of pesticides are reviewed regularly. The registrations on all suggested uses of pesticides in this publication were in effect at press time. Check with your county agricultural agent, State agricultural experiment station, or local forester to determine if these recommendations are still current.

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California Oakworm

By Boyd E. Wickman[1]

The California oakworm (*Phryganidia californica* Packard) is a common pest of oaks in the coastal valleys of California. Its larvae feed on the leaves, defoliating the trees. Their feeding reduces the amount of shade a tree can supply, and they irritate homeowners in other ways by dropping frass, and by crawling on walkways and into houses. Swarms of moths which emerge once the larvae have pupated compound the nuisance. The larvae often become so numerous that they destroy every leaf on the oaks, but an infestation rarely lasts long enough to cause tree-killing. Outbreaks usually decline after a year or two, as quickly as they appear.

Range and Hosts

The California oakworm has a limited range confined entirely within the boundaries of the State and mostly along the coast. The range extends from Humboldt County south along the coast to Long Beach in Los Angeles County. Moths also have been collected in Del Norte County in northwestern California and have been reported in San Diego County in the south. In the central part of the State they are found inland to Sacramento and Placer Counties.

California live oak and California white oak are its principal hosts, but the larvae will feed on nearly all oaks. They have also been reported as feeding on American chestnut, eucalyptus, azaleas, and tanoak.

Evidence of Infestation

The first signs of California oakworm activity are brown, pitted leaves that appear on California live oak in early spring. As feeding increases with the growth of the larvae, all the green leaves disappear from trees that are heavily infested and the ground beneath is covered with tiny green pellets. By this time the larvae are crawling everywhere searching for more food or for pupation sites.

Oaks stripped by feeding decline in vigor and their twigs and branches die back. The decline is reflected in loss of radial growth during years of heavy feeding. The oaks usually survive because of their ability to grow new foliage from adventitious buds after being completely defoliated.

Life Stages

The eggs of the oakworm are creamy white and are laid in rows, making irregular masses of 2 to 60. They usually are deposited on the underside of the leaf (fig. 1, *A*) but are sometimes placed on twigs or grass and even on brush. Each egg is smooth and rounded and about one twenty-fifth of an inch in diameter. As the embryo develops inside, the color of the egg changes to yellow, then to brown, and finally to a mottled pinkish gray. During this period a slight depression develops at the top of the egg.

When the larvae first emerge from the hatched eggs, they are about $\frac{1}{10}$ inch long, are gray in

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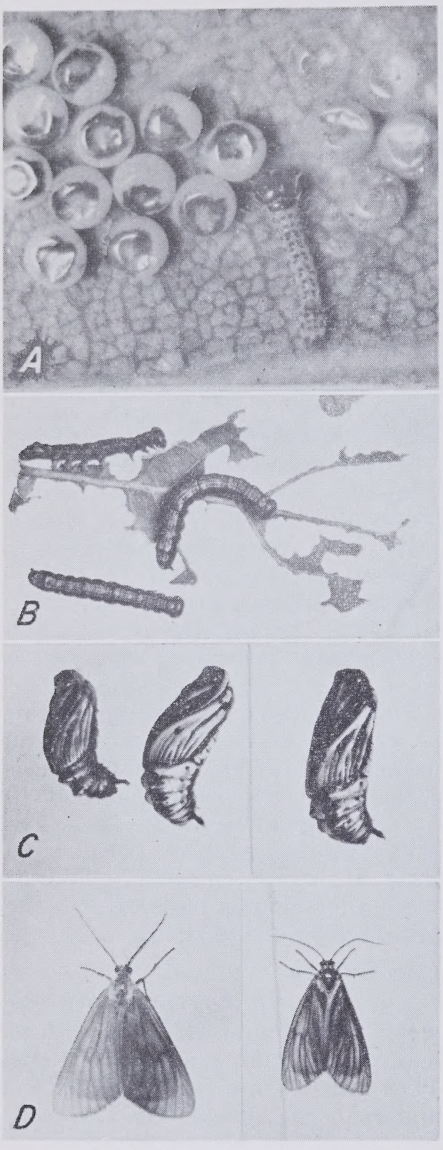

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FIGURE 1.—Life stages of the California oakworm: *A*, Eggs and newly hatched larva; *B*, full-grown larvae; *C*, pupae; *D*, adult moths (male on left).

color, and have prominent hairs and a large head. Soon after feeding starts, their color changes to brown with indistinct longitudinal red stripes. Between the third and sixth instars they stabilize to one of two color phases. A light phase, which is more common, has prominent dark longitudinal stripes on a green or yellow background; a less common dark phase has the reverse color scheme. When full grown the larvae are about 1¼ inches long, and hairless (fig. 1, *B*).

The smooth and shiny pupa is about ½ inch long and ⅙ inch broad (fig. 1, *C*). Its color varies from white to yellow with many black lines and splotches.

The moths are light brown with dark wing veins. The body is ½ inch long and the wingspread about 1¼ inches (fig. 1, *D*). The males have feathery antennae and faint yellow patches near the middle of the forewing.

Habits

The California oakworm normally has two generations a year—a 3-month summer brood and a 9-month winter brood. The winter brood depends on the evergreen live oaks for food. In the San Francisco Bay area, this brood lays its eggs in October. The summer brood, which may infest either live or deciduous oaks, lays its eggs in June and July.

The first generation eggs hatch from October through December, the second generation in July.

The young larvae feed on the soft surface tissue of the leaf veins, causing brown pitted patches, which last as long as the leaves remain (fig. 2). The older larvae chew their way from the edge of the leaf inward to the midrib. During epidemics every green part of the foliage disappears.

By September the worst of the year's leaf destruction is over, and the larvae crawl about seeking pupation sites. They pupate head downward on fence posts, buildings, and walls, but preferably on the lower trunks of oak trees. Larvae of the winter brood pupate in May and June and those of the summer brood in September and October.

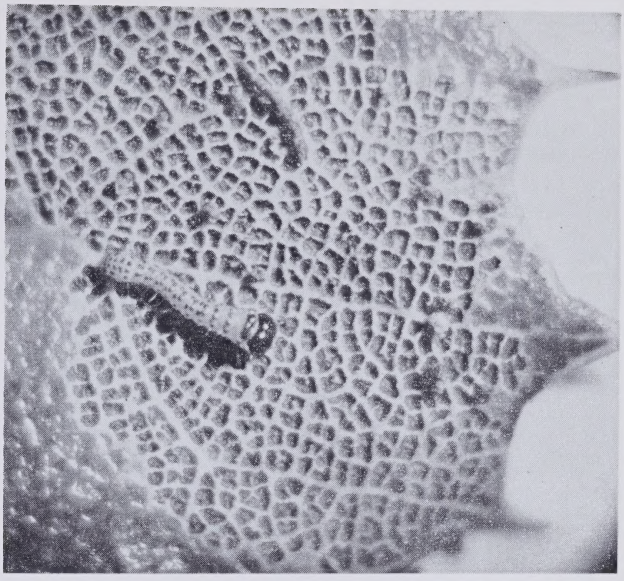

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FIGURE 2.—Young larvae feeding upon surface tissue of a live oak leaf.

The moths emerge in June and July from the winter brood and in October and November from the summer brood. Both sexes are weak fliers. During epidemics, clouds of them may be seen fluttering around oak trees. Mating and oviposition take place within hours after emergence. The adults have not been seen feeding. The sex ratio is 1 : 1.

The females produce about 225 eggs each and usually lay them on leaves high in the crown of the tree. Sometimes they lay eggs indiscriminately on anything they encounter, but larvae do not live unless the eggs hatch on a host leaf.

Natural Control

Natural enemies of the California oakworm are responsible for marked population changes. Within 2 or 3 years after an epidemic starts, a predator, parasites, and diseases usually decimate the population. The eggs, larvae, and pupae are punctured and sucked dry by the spined soldier bug, *Podisus pallens* (Stal.). The larvae are parasitized by a larvaevorid fly, *Actia* sp. Oakworm pupae are heavily parasitized by an ichneumonid, *Itoplectis behrensii* (Cresson), and a chalcid, *Brachymeria ovata* (Say). A nuclear polyhedrosis virus disease can wipe out dense larval populations. In one area, a microsporidian parasite, *Nosema phryganidiae* Lipa and Martignoni, was found attacking both the larval and adult stages of the insect.

Mass starvation also greatly reduces the numbers of both the oakworm and its natural enemies. During severe epidemics all the oak leaves may be consumed before the larvae reach full development. Their food supply cut off, the immature larvae eventually die.

Sometimes severe winter weather will kill great numbers of larvae and accomplish control.

When the California oakworm is reduced by high mortality from natural enemies or starvation, the numbers of parasites are also drastically reduced from lack of food. A few surviving oakworms start another generation, which may be almost free from parasites. As succeeding generations build up, so do the natural enemies, and once again the epidemic is cut off.

An important natural control factor in small populations is the

oakworm's habit of laying eggs indiscriminately on both deciduous and evergreen oaks. Since the deciduous oaks normally drop their leaves in the fall, all overwintering eggs and larvae on them are doomed, and only those overwintering eggs on the evergreen oak can perpetuate the population.

Applied Control

The foliage of oak trees may be protected from oakworm damage by applying insecticides to the crown of the trees. Because comparatively large trees are usually attacked, spraying is ordinarily done with power sprayers.

It is important to time this spraying properly in relation to oakworm development. The insecticide should be applied when the trees have fully leafed out and the larvae are small and have done little feeding. Do not wait until the trees are stripped of their leaves.

If moths are numerous in June and July, spray both deciduous and evergreen oaks around the end of July and the beginning of August. If there are many moths flying in October and November, spray during March and April. The important point is to catch the young larvae just after the eggs have hatched, so that spraying has to be done only once for each generation.

Where only one treatment can be applied, the best procedure is to spray evergreen oaks during the spring months. Unless rain falls, the insecticide will remain on the leaves long enough to affect both generations of larvae.

Lead arsenate is effective in protecting trees from oakworm damage. The recommended formulation is 3 pounds of lead arsenate powder dissolved in 100 gallons of water, with ½ pint of oil or other sticker added.

Organic insecticides, like DDT, applied as emulsion sprays should also be effective against this pest. They have a longer lasting effect and kill the insect through contact as well as through stomach action. But other insects that come in contact with these organic deposits may also be killed; consequently some property owners prefer to use only lead arsenate, which is somewhat more selective.

Caution: The insecticides recommended are relatively safe to use, but they contain toxic chemicals and therefore should be handled with care. Manufacturer's directions on the container should be carefully followed.

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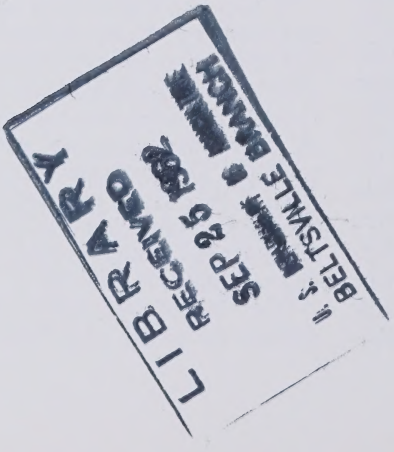

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